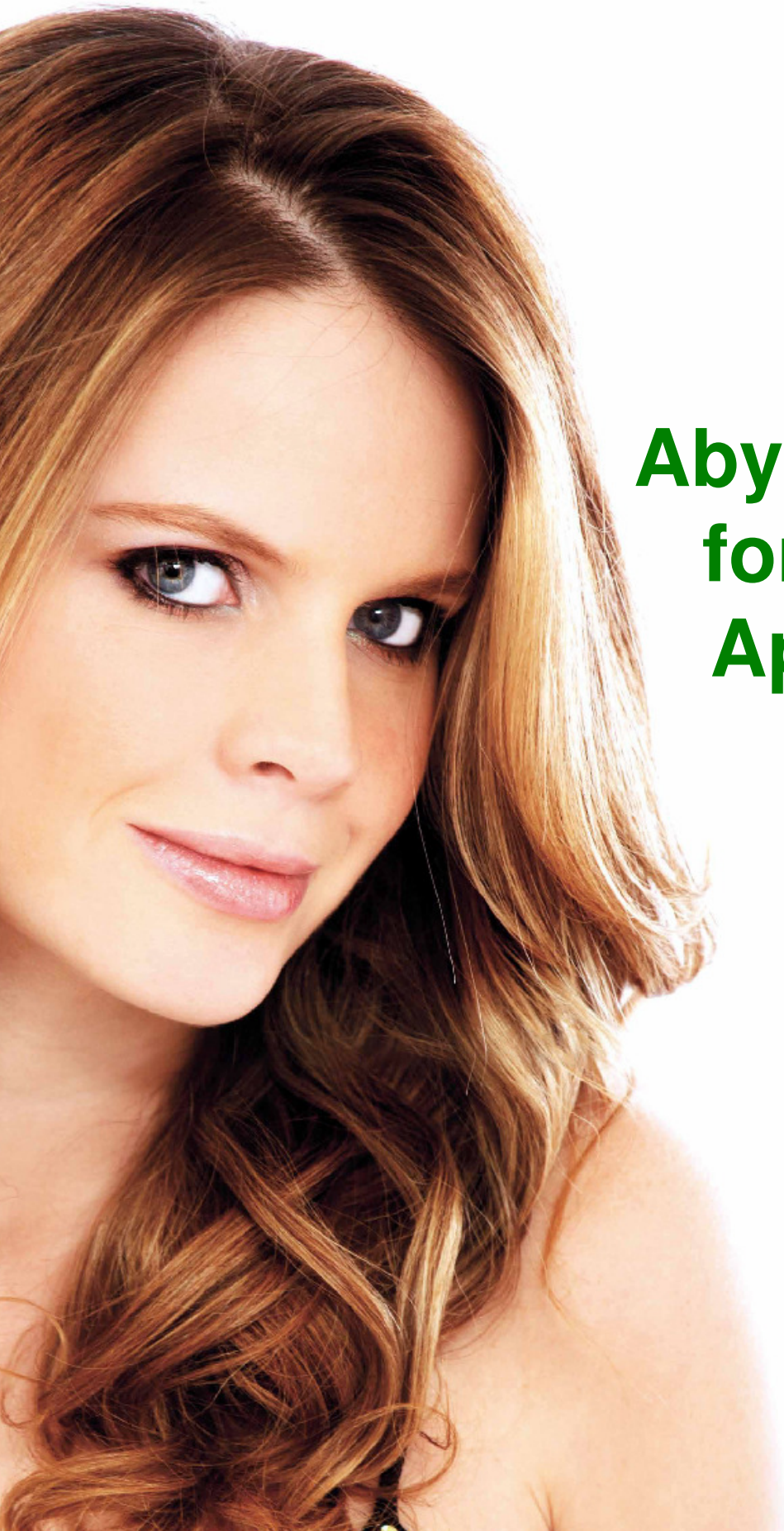


ELEMENTIS

SPECIALTIES



**FANCOR®**  
**Abyssinian Oil**  
**for Hair Care**  
**Applications**

# Introduction

Oils are an essential component to provide natural luster, lubricity and an emollient feeling to hair care products. Therefore different natural oils are commonly used in rinse-off and leave-in product for hair conditioning.

In this report we want to demonstrate the benefits and good performance of using FANCOR® Abyssinian Oil in Hair Care applications.

TRI Princeton, an independent non-profit scientific research and education institute located in New Jersey, USA and well known in the market for its applied hair science, conducted a study to evaluate the effect of FANCOR® Abyssinian Oil. In this study the benefit of FANCOR® Abyssinian Oil for increasing combability, hair strengthening, anti-breakage and detection of the shine of the hair after treatment for different ethnic hair types was determined.

Based on the results of the study we can claim that FANCOR® Abyssinian Oil has a very good overall performance in all evaluated aspects. It can increase the manageability, shine and strength of the hair.

FANCOR® Abyssinian Oil is a very effective natural hair conditioning agent.



# The Abyssinian Plant

The *Crambe Abyssinica* is an oilseed crop belonging to the family of Brassicaceae. It is known under the name Abyssinian Plant, Crambe or even Abyssinian mustard. It is an annual plant with a higher resistance against drought in comparison to other oilseed crops due to a long tap root. Only moderate rainfall for growth is necessary. It is native to the Ethiopian Highlands (also known as Abyssinia). Nowadays Abyssinian crops are also cultivated in mediterranean and temperate zones due to their ability to grow even in colder regions. Therefore the Abyssinian Plant can be successfully grown on a wide climate range. The breeding of this plant has been through natural selection without any genetic engineering. The plant can grow up to 1.5 m depending on the humidity during their growth period.



Figure 1. Abyssinian Plant

The Abyssinian plant needs around 50 days until it flowers with an additional 30 more days before the crops can be harvested. The typical flowering period is approximately three weeks and the hermaphroditic, four-leaved white flowers are numerous and small.

The Abyssinian Plant can be seen in figure 1.

The plant produces small yellow to brown colored seeds of around 3 mm diameter, see in figure 2. They contain approximately 30 % Abyssinian Oil.

Abyssinian Oil has a unique molecular structure not found in any other naturally occurring substance. It contains a high percentage of unsaturated  $C_{22}$  fatty acids. Furthermore, it has a high molecular weight and is very light in color and feeling on skin and hair.



Figure 2. Abyssinian Seed

# Abyssinian Seed Oil Processing and Appearance

FANCOR® Abyssinian Oil is removed from the *Crambe Abyssinica* seed using a mechanical crushing process. Elementis Specialties does not use an external heat source to aide the process. Unlike other oils, FANCOR® Abyssinian Oil is not produced via solvent extraction so it is a natural product. It is furthermore a non-GMO natural product. The oil is fully biodegradable and free from any additives. These green characteristics have enabled Elementis Specialties to gain **Ecocert** certification status for FANCOR® Abyssinian Oil.



Figure 3. FANCOR® Abyssinian Oil

FANCOR® Abyssinian Oil is a clear liquid oil and extremely light in color, even though it has a high molecular weight. The oil can be seen in Figure 3.

A flowcurve of the oil was measured using a Paar Physica MCR 300 Rheometer. The flowcurve, seen in Figure 4, show that Abyssinian Oil has a average viscosity of 0.09 Pa\*s and a newtonian flow behaviour.

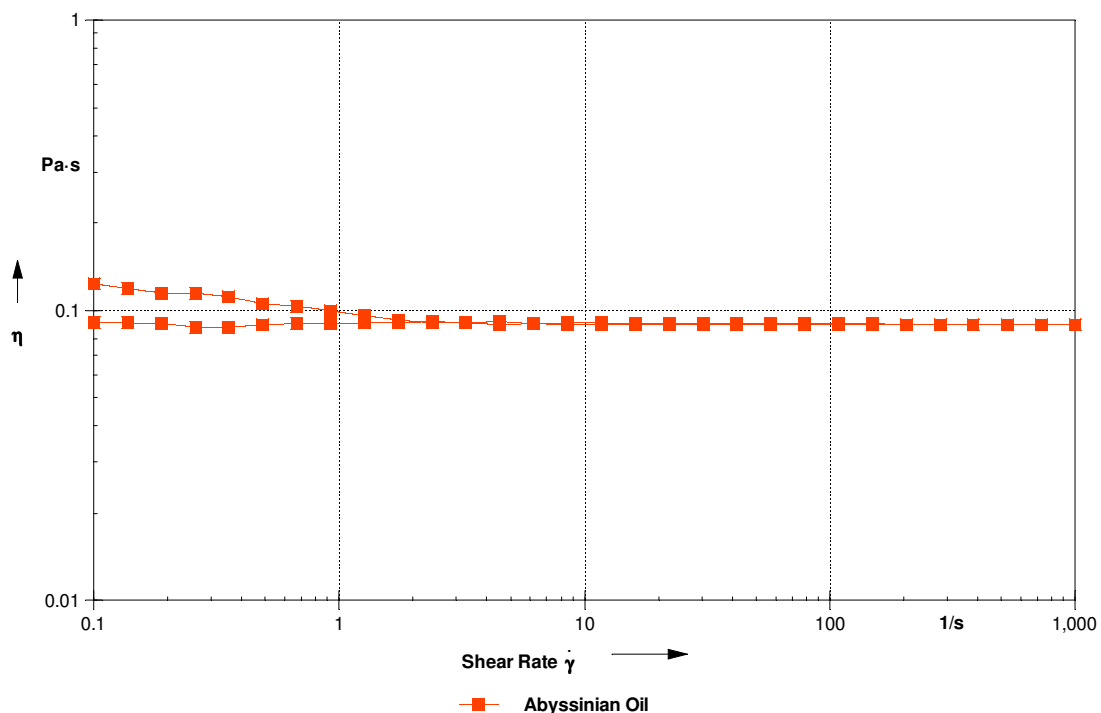


Figure 4. Flowcurve of FANCOR® Abyssinian Oil

# Abyssinian Oil Composition

FANCOR® Abyssinian Oil has a high percentage of unsaturated C<sub>22</sub> Omega-9 fatty acids. Abyssinian Oil provides moisturization to hair care products with a non-greasy after-feel. It is also desirable for providing emolliency and gloss to highly loaded pigment systems. The typical fatty acid profile of Abyssinian Oil is as follows:

	Abyssinian Oil
Erucic Acid C 22 : 1	58 %
Oleic Acid C 18:1	18 %
Linoleic Acid C 18 : 2	11 %
Linolenic Acid C 18 : 3	4 %
Palmitic Acid C 16 : 0	3 %
Stearic Acid C 18 : 0	1 %

Table 1. Fatty Acid composition of Abyssinian Oil

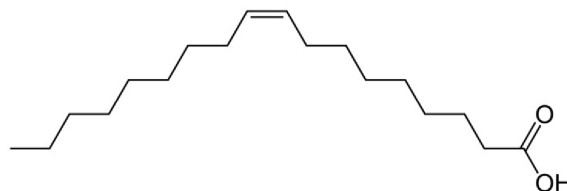
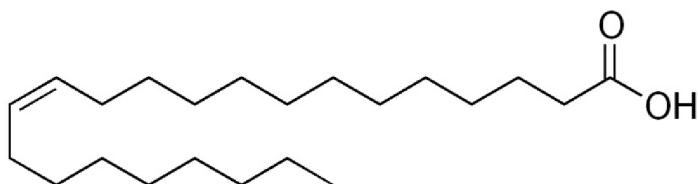


Figure 5. Erucic / Docosadienoic Acid C22:1 Structure

Figure 6. Oleic Acid C18:1 Structure

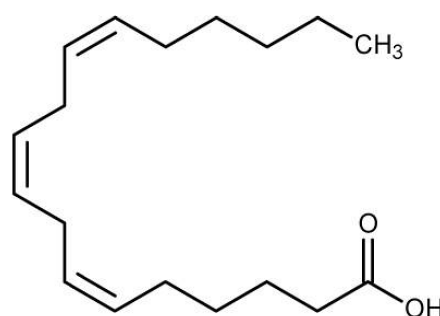
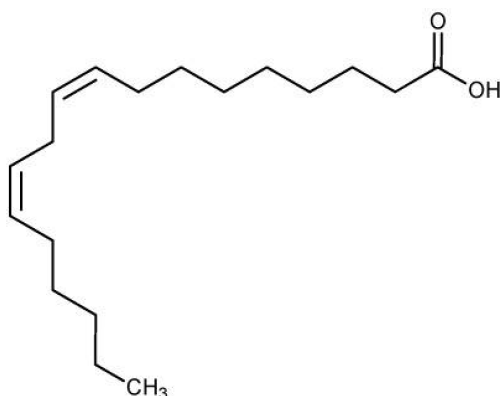


Figure 7. Linoleic Acid C18:2 Structure

Figure 8. Linolenic Acid C18:3 Structure

# Impact of treatment with Abyssinian Oil on Hair

Many claims are being made to demonstrate the effectiveness of hair care products. These include aspects like manageability of the hair, protection, strengthening of the hair fibres and anti-breaking properties. Furthermore a visible benefit like the enhancement of the natural shine of the hair is important to achieve customer satisfaction.

To prove the benefit of hair treatment with FANCOR® Abyssinian Oil Elementis Specialties sponsored an independent study that was carried out by **TRI Princeton**.



*Figure 9: Abyssinian Seeds on hair tresses.*

The tests were performed on Mulatto and Caucasian hair. Mulatto hair offers a combination of characteristics of different ethnic hair types mixed with African origin. Due to the ellipticity and high degree of curliness hair of African or Mulatto origin has a tendency to be very sensitive against damage. Therefore, an improved hair quality in this type of hair can demonstrate the benefit of a treatment with Abyssinian Oil very efficiently. Caucasian hair can be characterized as having straight hair texture which is resistant to damage, but has a duller appearance.

TRI Princeton conducted a **Dry Combing** test, a **Repeated Grooming** test and quantified the **Shine** of the hair. The hair tresses were cleansed with a non-conditioning shampoo, dried overnight under controlled humidity (60%) and afterwards the oils were applied to the hair at a dosage of 0,5 mL per 3 gram

hair tress.

Based on the results of three different test methods we can claim that FANCOR® Abyssinian Oil offers a high benefit in improving the manageability of the hair, enhancing the shine and strengthening the hair fibres. It can be claimed as being a natural replacement to synthetic ingredients in Hair Care products like silicones where shine, luster and a strengthening effect is needed.

## Measurement of hair manageability - Dry Combing

Most conditioning products claim to increase the manageability and combability of the hair due to lubrication and conditioning effect of the hair fibers. Improving the combability of the hair is perceived as the hair being in better condition. Better combability decreases the mechanical damage on the hair due to reduced combability force needed to untangle the hair, therefore, the combability of hair after treatment with conditioning agents provides an indicator if the effectiveness of the treatment is sufficient.

TRI Princeton used the Instron Tensile Tester to quantitatively evaluate the combability of Mulatto and Caucasian Hair treated with FANCOR® Abyssinian Oil (see figure 10, reference (1)).

Virgin Mulatto hair tresses and single bleached Caucasian hair tresses were used for this test. The Caucasian hair was bleached using 6 % peroxide solution.

To ensure statistical relevance eight standardized hair tresses were used per sample and eight times the combing force was measured.



*Figure 10. Instron Tensile Tester, TRI Princeton*

# Dry Combing Results

To comb untreated Mulatto hair it is necessary to use almost 2000 gmf frictional force due to its kinky structure. FANCOR® Abyssinian Oil effectively increased the combability by reducing the needed force down to 1.5 % of the force initially needed for untreated Mulatto Hair. In figure 11 this striking effect is obvious.

Single bleached Caucasian Hair, not treated with FANCOR® Abyssinian Oil, offers an average of needed frictional force for combing between 100 - 120 gmf declared by TRI Princeton based on historical data. We used this information in figure 12 by indicating the frictional force at 110 gmf. Compared to this data TRI Princeton treated Caucasian Hair with FANCOR® Abyssinian Oil was able to reduce the needed force down to 12 gmf. This implies a reduction down to approximately 10 - 12 % of the initial force needed for untreated Caucasian Hair.

Therefore the treatment of both Mulatto and Caucasian Hair with FANCOR® Abyssinian Oil has a significant positive effect for conditioning and a better manageability of the hair. This benefit is more remarkable for Mulatto Hair by a reduction of the necessary force of 98 %. But the advantage to use Abyssinian Oil for straight, Caucasian hair is also clear, substantial and lead to a reduction of the necessary force of 88 %.

### Dry Combing - Mulatto hair

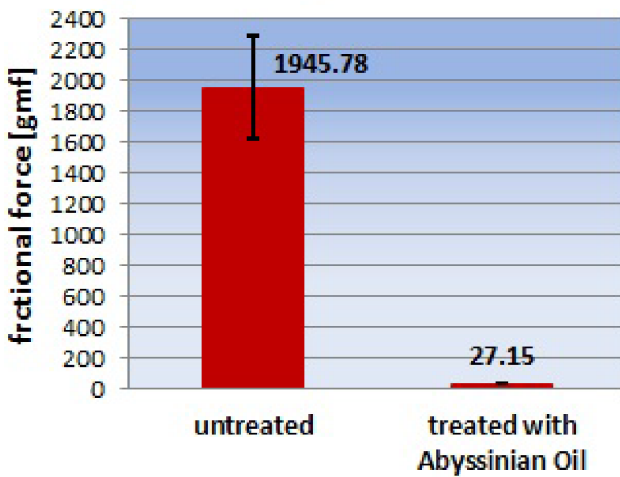


Figure 11. Dry Combing results for untreated Mulatto Hair and treated with Abyssinian Oil.

### Dry Combing - Caucasian hair

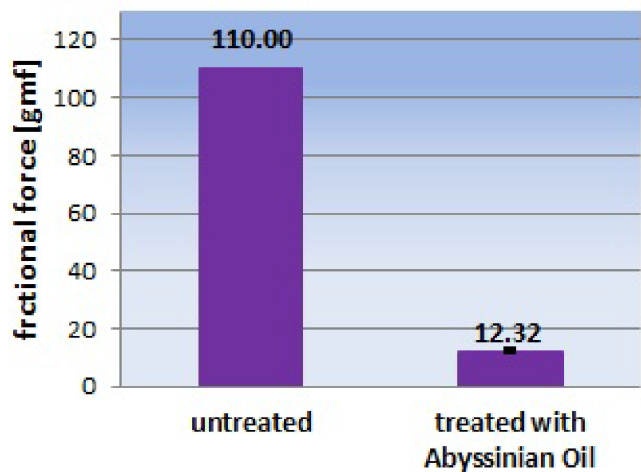


Figure 12. Dry Combing results for untreated Caucasian Hair (from historical data provided by TRI Princeton) and treated with Abyssinian Oil.



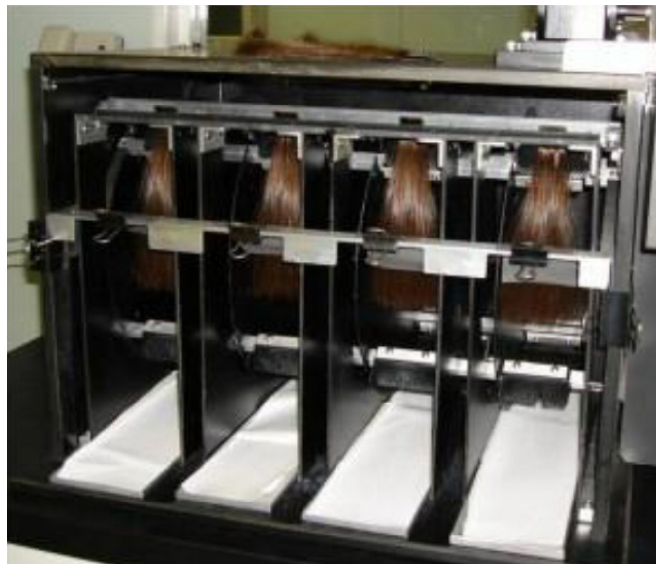
# Measurement of Anti-Breakage and Strengthening Repeated Grooming

The ability of natural oils to coat the hair fibers and to reduce snag, entanglements and abrasion lead to strengthening of the hair. This effect is linked to the phenomenon of anti-breakage, which is a common problem in real life due to different stress factors like grooming and hair-dressing. To enable the hair fibers to stay in good and healthy-looking shape, although being confronted with this potential damaging procedure, is highly appreciated by consumers of hair care products.

A Repeated Grooming experiment was used to quantify the strengthening and anti-breaking effect of FANCOR® Abyssinian Oil, which evaluated broken fibers after repeated combing strokes (see reference (2)). Ten hair tresses per treatment were used to ensure statistical relevance and brushed 10,000 times, then the broken fibers are counted and analyzed. The Repeated Groomer device is shown in figure 13. It consists of a chamber and four rotating combs. The broken fibers are collected on a plate under each tress.

The Mulatto Hair was chemically relaxed twice and the Caucasian Hair was bleached three times. This is a common technique to improve the sensitivity and to simulate the conditions where persons are treating their hair chemically to modify their natural look.

This experiment shows a reasonable representation of real-life conditions and the potential reduction of hair fiber breakage due to conditioning agents.



*Figure 13. Repeated Groomer set-up, TRI Princeton*

# Repeated Grooming Results

Untreated Mulatto hair showed a high number of 170 broken fibers per 10,000 strokes which reflected a higher breakage potential in comparison to Caucasian hair that yielded around 80 - 100 broken fibers per 10,000 grooming strokes. The effect of using FANCOR® Abyssinian Oil is impressive as it reduced the number of broken fibers for untreated Mulatto hair with 93 %. In figure 14 this anti-breakage effect is obviously.

Untreated Caucasian hair yields around 80 - 100 broken fibers under this conditions declared by TRI Princeton based on historical data. We used this information in figure 15 by indicating the numbers of broken fibers per 10,000 strokes at 90. FANCOR® Abyssinian Oil effectively reduced the number of broken fibers for untreated Caucasian hair by 55 %.

Although being effective for both hair types the effect is more obviously for Mulatto hair. But a benefit of using FANCOR® Abyssinian Oil to strengthen the hair for both hair types is obviously, but due to the different hair treatment the results cannot be compared directly.

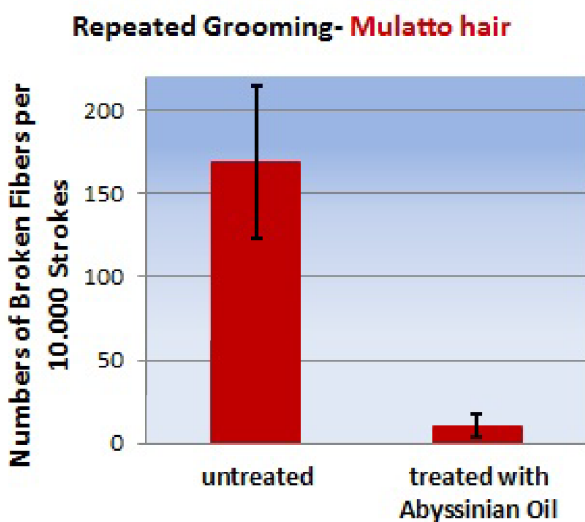


Figure 14. Repeated Grooming results for untreated Mulatto Hair and treated with Abyssinian Oil.

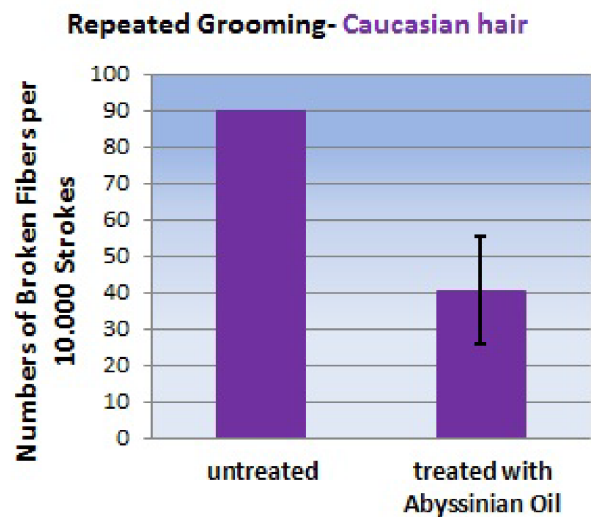


Figure 15. Repeated Grooming results for untreated Caucasian Hair (from historical data provided by TRI Princeton) and treated with Abyssinian Oil.

## Quantification of Shine

The shine of the hair is a very highly appreciated attribute of healthy-looking hair and is often a claim of hair care products.

The commercially-available SAMBA device by Bossa Nova was used to quantify the shine enhancement of FANCOR® Abyssinian Oil, seen in Figure 16. This method was developed to measure the luster and shine of the hair tress by light reflected from a curved hair tress (see reference (3)). The quantification is based on an image analysis by scanning the light distribution of a hair sample across highlighted and dark areas. The resultant image was evaluated by using image analysis software with developed macros.

In general the hair pigmentation has a significant effect on the optical properties of hair and on its luster, see reference (3). Hair with low pigmentation reflects the light which results in a broad light distribution. The luster is calculated as a function of light intensity and the distance along the hair tress, therefore dark hair has the narrowest light distribution. This results in increasing luster for increasing pigmentation of the hair.

To ensure statistical relevance TRI Princeton evaluated eight tresses per sample.

The Mulatto Hair that was used non-chemically modified, the Caucasian Hair was bleached once.

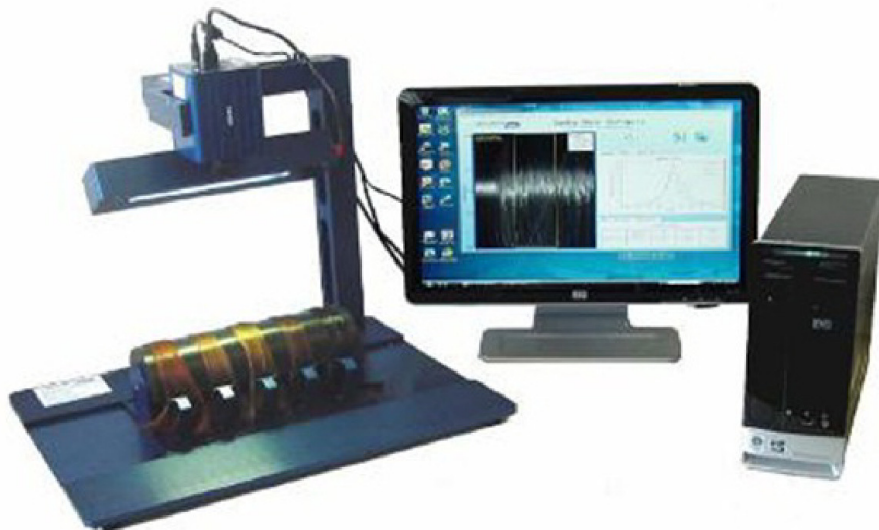


Figure 16. SAMBA device for shine measurement. TRI Princeton

# Results of Shine measurements

The natural shine of untreated Mulatto Hair is around 165 technical shine units (in Reich-Robbins units, see reference (3)). The effect of using FANCOR® Abyssinian Oil to enhance the shine of the hair is impressive by almost doubling the apparent shine on the Mulatto hair in comparison to untreated hair up to 289 units. These results can be seen in Figure 17. Typical values for bleached Caucasian hair by this method are around 18 - 20 units, which corresponds to a much duller initial state for this hair structure. This value were provided by TRI Princeton from historical data. FANCOR® Abyssinian Oil has the ability to increase the shine of Caucasian hair to 88 units, which is more than 4.4 fold of the initial shine. These results can be seen in Figure 18.

Due to this results it can be claimed, that FANCOR® Abyssinian Oil is a natural shine enhancer. It can be used as a natural replacement to synthetic oils like silicones in Hair Care products where shine and luster is needed.

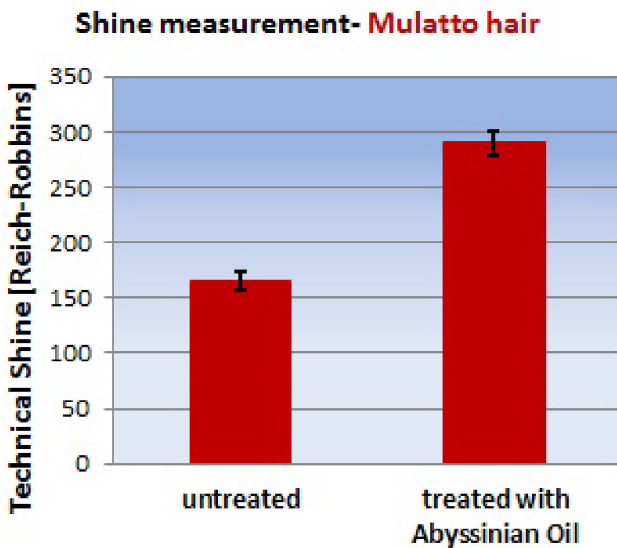


Figure 17. Shine results for untreated Mulatto Hair and treated with Abyssinian Oil.

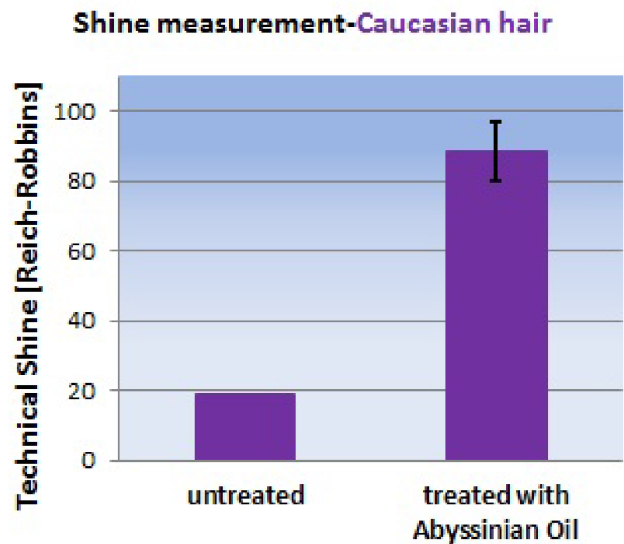


Figure 18. Shine results for untreated Caucasian Hair (from historically data provided by TRI Princeton) and treated with Abyssinian Oil.

## Summary

FANCOR® Abyssinian Oil is a natural hair conditioning agent with numerous benefits. The great performance of FANCOR® Abyssinian Oil for Hair Care applications have been displayed in the test results presented in this report. It increases the manageability of the hair, strengthens it and makes it more resistant against external stress like grooming with an anti-breakage effect. Furthermore it is a very effective shine enhancer although being non-greasy. These benefits can be seen on different hair structures like Mulatto and Caucasian Hair.

Therefore it can be used as a natural replacement for other oils used in Hair Care applications and synthetic ingredients like silicones and mineral oil. Abyssinian is an annual crop that is planted each year and yields seeds within months, which makes it a very reliable oil source.

Below we have highlighted the different benefits of using FANCOR® Abyssinian Oil in Hair Care products:

### Conditioning Effect

- FANCOR® Abyssinian Oil increased the combability both on Mulatto and Caucasian hair. The positive effect is even more obvious on the kinky Mulatto Hair, which is known to be more difficult in styling.

### Anti-Breakage Effect

- Repeated Grooming test showed the capability of FANCOR® Abyssinian Oil to strengthen the hair and significantly reduce the breaking of hair fibers. Especially on the more sensitive and easily breaking Mulatto Hair FANCOR® Abyssinian Oil offers a dramatic benefit even outperforming the effect on Caucasian Hair.

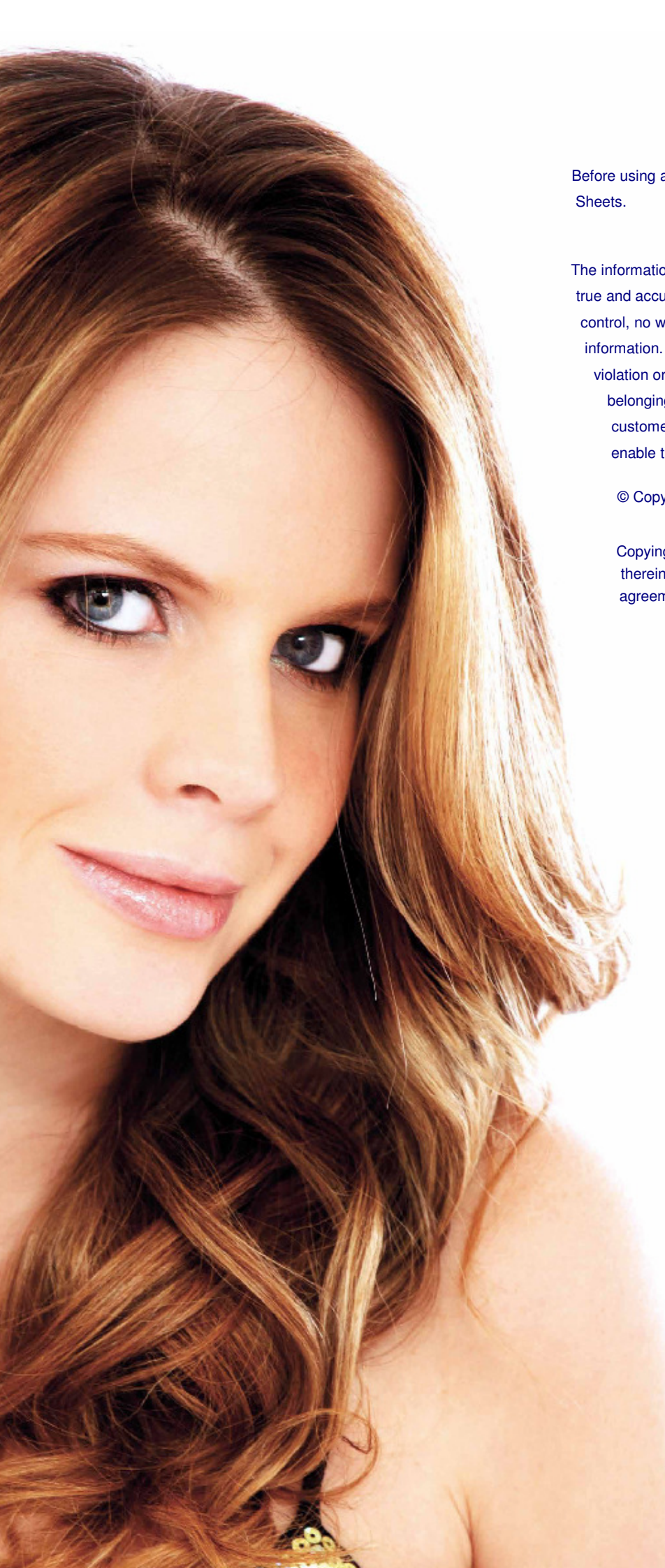
### Natural Shine Enhancer

- The shine enhancing capability of FANCOR® Abyssinian Oil can be impressively demonstrated on both hair types, which had been evaluated. FANCOR® Abyssinian Oil can almost double the shine of Mulatto Hair and the shine of initially duller Caucasian Hair can be enhanced 4.4 fold.

## References

- (1) Garcia M.L., Diaz J., JSCC, 27, (1976) 379-398 - Combability Measurements on Human Hair
- (2) Evans T.A., Park K., JSCC, 61, (2010) 439-455 - A statistical analysis of hair breakage. II. Repeated grooming experiments
- (2) McMullen R., Jachowicz J, JSCC, 54, (2003) 335-351 - Optical properties of hair: effect of treatments on luster as quantified by image analysis





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